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THE AMERICAN

METEOROLOGICAL JOURNAL.

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# CHANGES IN THE DEFINITIONS OF CLOUDS SINCE HOWARD.

H. HELM CLAYTON.

THE publication of Hellmann's reprint of Howard's original essay, "On the Modifications of Clouds," brings to notice the changes which have since taken place in the definitions of Howard's principal cloud forms. The differences have principally originated in regard to the lower cloud forms. The cirrus, cumulus, and cirro-cumulus are forms so well defined that little or no difference of opinion in regard to the clouds intended to be described by these names has arisen. The clouds to which the name cirro-cumulus has been given have very great differences in altitude and size, and the lower form of these clouds is now called *alto-cumulus*. The name cirro-stratus appears also to have been generally used to describe high cloud sheets, though Howard's definition does not appear very clear on this point, and in a few cases has led to differences of opinion. Poey, for example, pictures cirro-stratus as high white fragments or short parallel bars. By others, comparatively low cloud sheets have been recorded as cirro-stratus. In the International nomenclature the name cirro-stratus is confined to high white veils of cloud, and the darker, lower cloud veils above the cumulus level are called *alto-stratus*.

The greatest differences have arisen in regard to the form of cloud which should be recorded under the name of stratus.

Howard's definition of stratus is: "*Nubes strata, aquæ modo expansa, deorsum crescens*, — A widely extended, continuous, horizontal sheet, increasing from below." He further explains: "This modification has a mean degree of density. It is the lowest of the clouds, since its inferior surface commonly rests

on the earth or water. Contrary to the last [the cumulus], which may be considered as belonging to the day, this is properly the cloud of night; the time of its first appearance being about sunset. It comprehends all those creeping mists which in calm evenings ascend in spreading sheets (like an inundation of water) from the bottom of valleys and the surface of lakes, rivers, etc. Its duration is frequently through the night. On the return of the sun the level surface of this cloud begins to put on the appearance of cumulus, the whole at the same time separating from the ground. The continuity is next destroyed, and the cloud ascends and evaporates, or passes off with the appearance of the nascent cumulus. This has been long experienced as a prognostic of fair weather, and, indeed, there is none more serene than that which is ushered in by it."

Kaemtz in his "Lehrbuch der Meteorologie," Halle, 1831, vol. I., p. 378, gives the following definition of stratus which is seen to be very similar to that of Howard: "Der *Stratus*, oder die *Schichtwolke*, ist eine oben und unten horizontal begränzte Nebelschicht, welche wir an bestern Sommertagen über Wiesen und Gewässern liegen sehen, die sich beim Untergange der Sonne bildet und nach ihrem Aufgange wieder verschwindet. Es gehören hierzu also die feinen Nebel, welche wir oben bei der Thaubildung kennen lernten, sowie die niedrigen Nebelschichten über den Polarmeeren." In the French and English translation of Kaemtz this definition became changed as follows: "The *stratus* is an horizontal band, which forms at sunset and disappears at sunrise." In the picture given, it is represented as little thin streaks along the horizon. — Kaemtz's "Meteorology," by C. Walker, London, 1845. Schmid says in the "Allgemeine Physik," Leipzig, 1860, p. 670: "Der *Stratus* oder die Schichtwolke breitet sich mit horizontaler Oberfläche unmittelbar über den Boden aus." (The stratus, or bed-cloud, spreads itself with horizontal upper surface directly over the ground.)

In Herschel's "Meteorology," Edinburgh, 1861, p. 98, the definition is as follows: *Stratus* consists of horizontal sheets. Its situation is low in the atmosphere, and may be considered as intermediate between cloud and fog, being chiefly formed at night, and under the influence of radiation either from the surface of a ground fog (as already described), or from impurities floating in the air itself."

Elias Loomis, in his "Treatise on Meteorology," p. 102, New York, 1868, says: "The stratus cloud is a widely-extended, continuous, horizontal sheet, often covering the entire sky with a nearly uniform veil. This is the lowest of the clouds, and sometimes descends to the earth's surface."

In "Modern Meteorology," London, 1879, p. 134, Clement Ley says: "The anti-cyclones, or areas of high barometer, are, as already mentioned, in a general way, areas of fine and settled weather. In summer we commonly see within these areas almost cloudless skies. A little stratus occurs at night on some occasions, at an elevation of from four thousand to ten thousand feet, and this is developed into cumulus of moderate dimensions during the day, while the unwashed atmosphere is usually slightly obscured by the haze produced from smoke and dust. At a great elevation cirrus may often be seen in comoid tufts, whose movement is extremely slow. In winter, on the other hand, neither cumulus nor cirrus is common near the central parts of an anti-cyclone; but the sky is rarely clear. A bed of nearly stationary stratus often covers the heavens for many days and nights in succession. This bed is frequently of vast extent, but of very small vertical thickness. Where gaps occur in it, such as that which I have tried to portray in the illustration which you now see (Fig. 7) we observe a sky totally devoid of every species of upper cloud. Now we infer, from facts which I cannot stay to describe to you, that there is over every anticyclonic area a slight general downward movement of the atmosphere. In summer the sun's rays dissolve the stratus, and the rapid evaporation taking place during the long and hot days sends up the local or scattered patches of cumulus or cirrus. In winter this does not take place." The picture of stratus, which Ley here refers to as No. 7, shows a low, thin sheet of cloud with a broken spot through which can be seen the blue sky.

In his "Classification des Nuages employée à l'Observatoire météorologique d'Upsala," p. 7, Hildebrandsson says:—

"On voit que le Stratus n'est pour Howard autre chose qu'un brouillard; à Upsala nous désignons aussi sous le nom de Stratus, le brouillard qui s'est éleveé de la terre et qui plane ordinairement par parties isolées à une faible distance au dessus du sol." (One sees that the stratus of Howard is nothing but a

fog; at Upsala we designate also under the name of stratus fog lifted above the earth which exists ordinarily as isolated fragments at a slight distance above the ground.) Mohn in his "Grundzüge der Meteorologie," p. 184, Berlin, 1883, says: "Stratus ist eine niedrige Wolke, ein sich erhebender Nebel." (Stratus is a low cloud, a lifted fog.)

Assuming that stratus as described by Howard was merely a ground fog, G. Tissandier says in "L'Océan Aérien," Paris, 1884, page 85: —

"On va voir dans la suite de ce chapitre que dans un grand nombre de cas les masses de vapeur ou les bancs d'aiguilles de glace que l'on rencontre en suspension dans l'air ne se rapportent à aucun des quatre types définis par Howard, et que la nomenclature adoptée par les météorologistes est assurément incomplète. Nous citerons, par exemple, un cas très fréquent où le système de classification actuel est pris en défaut. Le temps à la surface du sol est clair, mais le bleu du ciel ne se voit pas, il est caché par une masse de vapeurs qui n'a pas de forme définie, et qui se présente comme un rideau de brume; on dit que le ciel est gris. Si l'on traverse en ballon cette masse de vapeurs, on s'assure qu'elle est séparée de l'air par deux surfaces, l'une inférieure, un peu confuse, qui se fond graduellement avec l'air qui est de couleur grise comme le brouillard, l'autre supérieure, parfaitement plane, d'un blanc éblouissant, comme une nappe de neige en pleine lumière. En bas, sur la terre, l'observateur n'a pu constater qu'une brume plus ou moins épaisse; en haut, dans l'atmosphère, l'æronaute considère sous ses pieds un véritable plateau qui rappelle l'aspect, comme éclat, des cumulus d'un beau ciel d'été. Mais, si cette surface supérieure est tout à fait lisse et unie comme celle d'un lac, et le cas se présente assez souvent, il a sous les yeux une sorte de banc de vapeur, brume à sa partie inférieure, nuage à sa partie supérieure, qu'il ne pourra attribuer à aucun des types de la classification."

These low cloud veils which Tissandier says are frequently encountered by aeronauts and sometimes float at an altitude of only about 200 meters above the ground are apparently the same as the stratus accompanying anticyclones, described by Ley.

In his "Elementary Meteorology," London, 1885, page 126, R. H. Scott says: "*Stratus* is a form of cloud about which there has been a persistent misconception, as there has been a ten-

dency to give that name to every thin layer of cloud seen on the horizon. Howard's definition of stratus is 'a widely extended, continuous horizontal sheet increasing from below upward.' It is a sheet or layer of cloud, of uniform thickness generally. It has but little variety of light and shade, and belongs essentially to the lower regions of the atmosphere, so much so, that Howard speaks of it as 'ground fog,' the cloudy formation which spreads over low grounds in the evening, and disappears as soon as the temperature rises in the morning. Stratus is generally a fine-weather cloud, appearing during the evenings and mornings of the brightest days. At times it overspreads the whole sky in the form of a low, gloomy, foggy canopy, the atmosphere being more or less foggy under it. All low detached clouds which look like a piece of lifted fog, and are not in any way consolidated into a definite form, are *stratus*." Scott being head of the English Meteorological Office, this is assumed to be the official definition used by the weather observers in that country.

In the "Lehrbuch der Meteorologie," of Sprung, Hamburg, 1885, page 320, it is said: "Die zweite Hauptform der Wasser-Wolken ist durch vorwiegende Flächen-Entwickelung und geradlinige Grenzlinien charakterisirt; es ist die Schichtwolke oder Stratus. Man darf sie wohl als Nebel-Bänke betrachten, welche nicht bis zur Erdoberfläche herabreichen, indem auch die Bedingungen ihrer Entstehung dieselben sind. Ihre Grenzflächen sind meist unbestimmt und gefranzt, ihre Struktur ist eine wenig dichte, ihre vertikale Ausdehnung meist gering."

It is seen from this that Sprung recognizes as stratus those low horizontal cloud sheets or beds with indefinite bounding surface and small vertical height. In a foot-note he says the thick and low winter clouds, which frequently cover the heavens with a uniform gray for weeks at a time, should be recorded as stratus.

In his book on "Weather," London, 1887, page 82, Abercromby says: "We now come to the second variety of clouds, to which the name of stratus is applied, because it always lies in a thin horizontal layer, like a stratum of rock or clay. Pure stratus has no sign of any hairy or thread-like structure except at the edges, for a stratum which shows much marking would be cirro-stratus, and has quite a different origin. Pure stratus is essentially a fine weather cloud, and is especially characteristic of anticyclones. One very beautiful variety is often seen dur-

ing a fine night, when the cloud forms thin broken flakes, something like mackerel sky, from which, however, it is really quite distinct. In Howard's original work on clouds, 'stratus' was applied to ground mist, but that idea is now entirely discarded by all meteorologists." In his "Instructions for Observing Clouds," London, 1888, page 12, Abercromby says: "*Stratus* — a thin uniform layer of cloud at a very low level, . . . but the sky is often covered with detached masses of flat structureless clouds, which must also be reported as stratus." His picture shows a low sheet of cloud which he says is exceedingly characteristic of east winds in London.

In the "Lehrbuch der Meteorologie," of Van Bebber, Stuttgart, 1890, page 178, it is said: "Haben die unteren und oberen Luftströmungen verschiedene Richtungen, oder sind die horizontalen Geschwindigkeiten in den verschiedenen Höhen verschieden, dann wird die Wolke streifen-förmig auseinandergezogen und erhält so eine geschichtete Lagerung. Diese Wolke, Schicht-oder Stratuswolke genannt, erscheint als eine lang hingezogene Schichte, die oft den ganzen Himmel teppichartig überzieht; ihre Streifung und Richtung, wenn sölche vorhanden ist, ist bedingt durch die Richtung des Oberwindes in bezug auf diejenige des Unterwindes.

"Ein gutes bild dieser Wolke gewähren die lang-gestreckten bandartigen Nebel-streifen, welche sich an heiteren Sommertagen sehr häufig über Wiesengründe hinziehen." Here is found a different conception of stratus from that previously given. It is more like the definition in the English edition of Kaemtz than Howard's. Stratus is defined and pictured as long, flat, parallel bands drawn out by the wind.

In the Hildebrandsson-Köppen-Neumayer Cloud Atlas, Hamburg, 1890, stratus is thus defined: "LIFTED FOG. Condensations in the lowest stratum, which occur when the weather is not actually rainy and do not lie exactly on the ground; for in the first case they are designated as nimbus, or fracto-nimbus, and in the latter, as fog. The horizontal uniform layer of cloud, of slight thickness, in the atmosphere, above one thousand meters, which is frequently denoted as stratus, is to be designated, according to the classification of Abercromby and Hildebrandsson, partly by alto-stratus and partly by strato-cumulus." The picture given as a typical illustration of the cloud represents

a ragged mass of lifted fog, such as are seen in mountainous regions, or in other countries, after a foggy morning when the fog is breaking up and rising in fragments which slowly dissolve or change to cumulus.

In this JOURNAL for October, 1891, page 255, Prof. Abbe says: "At Cape Ledo I found the finest imaginable opportunity to study the formation of the overflow from the summit of the cumulus clouds, and its gradual transformation into slowly dissolving stratus; this stratus overflow so closely simulates the cirro-cumulus clouds that it would be called "cirro-cumulus," in the Howard nomenclature, but I shall uniformly designate it as dissolving stratus or cumulus overflow whenever I am able to trace it back to its origin." Here is a conception of stratus which seems very different from that of Hildebrandsson.

In "Das Wetter," June, 1892, pages 135, 136, C. Kassner criticises the definition and picture given of stratus in the Hildebrandsson-Köppen-Neumayer Atlas. He points out the inconsistency of calling high sheet clouds cirro-stratus and alto-stratus, and then representing stratus as a broken, ragged fragment of cloud, and proposes that the name stratus should be confined to clouds between one and two kilometers' altitude, which form in sheets or beds (Schichtwolken), and that the "lifted fog" of Hildebrandsson should have a separate name as *alto-nebulus* or *alto-nebulosus*.

M. Möller, in the "Meteorologische Zeitschrift" for November, 1892, brings the same objection against Hildebrandsson's conception of stratus. He says: "Hierbei sei eingeschaltet, dass nach unserer Beobachtung der gehobene Nebel kaum derartige, Strati genannte, Wolken bildet, sondern vielmehr zu Kumuli, Haufenwolken, sich zusammenballt. Es ist fraglich, ob die auf Tafel 10 benutzte Bezeichnung Stratus für derartig niedriges Gewölke zweckmässig beizubehalten sei; diese Frage ist im Abschnitt Schichtwolken behandelt."

He says further on: "Anhaltender Landregen fällt mithin nicht aus den Nimbus-Wolken, welche in der Erklärung des Atlas unter 7 Regenwolken genannt sind, sondern aus höheren Wolkenschichten herab. Dieses Schicht Gewölk verdient den namen 'Stratus' denn es ist das ausgedehnteste Wolkengebilde das überhaupt vorkommt; es breitet sich nach Art einer Decke über Landstriche bis zu 100 Meilen Erstreckung aus."

In reply to a criticism similar to that of Kassner and Möller made by the writer, in which he called attention to what appeared to be a difference between the definitions of Hildebrandsson and Abercromby, Hildebrandsson said in the "Meteorologische Zeitschrift," 1893, "Literaturbericht," page (45): "Wir Beide betrachen Stratus als Nebelwolken, 'Unteres Gewölk' des Herrn Vettin, oder die Kondensationsformen in den niedrigsten Schichten der Atmosphäre. Diese Nebel, hohe wie niedrige, bilden sich bekanntlich wie 'a thin uniform layer' und Abercromby hat sie darum so beschreiben. Da sie aber nachher zerrissen werden und in allen möglichen phantastischen Formen auftreten, so habe ich es richtiger gefunden Stratus nur als Nebelwolken oder 'elevated fog floating in the air' zu charakterisiren."

In the "Elementary Meteorology" of Davis, Boston, 1894, page 178, stratus is thus described: "This name was originally applied to low-lying fogs, such as form at night or in cold quiet winter weather on lowlands or in valleys; it has been extended to include low, foggy cloud sheets floating overhead, but with the base at a moderate height. It should not be applied to thin cloud sheets commonly seen at sunset at a great altitude; these being either fading strato-cumulus or alto-stratus. When lying on the earth, the stratus cloud is simply called fog. NIMBUS: Any extended cloud from which rain or snow is falling is commonly called nimbus; it is generally preceded by stratus, and still earlier by alto-stratus."

The definition of stratus used by the observers of the United States Weather Bureau is as follows: "A widely extended, continuous, horizontal sheet, increasing from below upwards. The stratus is the lowest of the clouds, and when it extends to the earth it is called fog. It consists of a thick veil of vapor of a dark color. When observed along the horizon it has the appearance of an irregular band of vapor." (General Instructions to Observers of the Signal Service, Washington, 1887, page 57.)

It will be seen from these quotations that there has come about a gradual change in the definition of stratus since Howard's time. "The widely extended continuous horizontal sheet," the inferior surface of which Howard, in 1803, says, "commonly rests on the earth or water," by the time of Loomis, in 1868,

only "sometimes descends to the earth's surface," and by the time of Abercromby, in 1887, "that idea is now entirely discarded by all meteorologists." Stratus then becomes "a thin uniform layer of cloud at a very low level"; and beds of condensed vapor, the inferior surface of which rests on the ground, are called fog.

It is said by many writers that Howard's stratus was merely a fog, but I do not understand him thus. Howard did not say that stratus *always* rested on the earth or water, but only that it "commonly" did so; and there are several passages of Howard which seem to the writer to indicate that Howard called all low cloud sheets *stratus*, embracing mist and fogs, which were the most common form of the cloud. These passages are too long to quote here. The gradual separation of stratus into a cloud and a fog is a similar process of evolution to that which has occurred with several of the other cloud forms, where differences not recognized by Howard are now distinguished.

In looking through the various definitions of stratus given in the preceding pages, it is seen that there are several which depart from Howard's original idea of stratus as a low continuous, horizontal sheet. The definition attributed to Kaemtz, of a horizontal band seen at sunset, is now entirely discarded. The parallel bands of Van Bebber would probably now be called strato-cumulus. The high sheets formed from the tops of cumulus called by Abbe stratus, should more properly be called stratiform cloud, or by the new name alto-stratus, if the almost universal idea of stratus as a very low cloud is to be retained. The intermediate cloud between nimbus and alto-stratus, which Davis calls stratus, and which Möller says deserves the name of stratus, would still be called by Hildebrandsson alto-stratus. It is at a higher level and occurs under different conditions from stratus proper, which is essentially an anticyclonic cloud. It is a cloud to which the name of *pallio-stratus* might well be given. The low ragged fragment of "lifted fog" represented in the Hildebrandsson-Köppen-Neumayer Cloud Atlas is equally difficult to reconcile with the almost universal idea of stratus as a sheet cloud (Schichtwolken, nappe des nuages).

The low sheet of cloud which sometimes covers the sky for days as a gray veil, and is in no sense "lifted fog" is now recorded as stratus over all the United States and Canada, an area as

large as all Europe, and also in many parts of Europe (as indicated by the definitions of Scott, Ley, Abercromby, and Sprung.) If usage is to be followed, as indicated by Abercromby and Hildebrandsson in forming their nomenclature, and endless confusion avoided, then in the Cloud Atlas, now being prepared by the committee appointed at the Munich International Conference, stratus should be represented as a sheet cloud like that given by Abercromby in his "Instructions for Observing Clouds," London, 1888, rather than by the ragged fragment shown in the Hildebrandsson-Köppen-Neumayer Atlas. It would avoid confusion and add to the definiteness of the terminology if these ragged fragments of elevated fog were called fracto-stratus which Hildebrandsson, as shown in the quotation from the "Zeitschrift," admits they really are.

A definition of stratus which appears to the writer to best embody the current ideas of this cloud is as follows: A stratus is a widely extended, continuous, horizontal sheet of cloud (Wolkenschicht, nappe des nuages), or a cloud having much greater horizontal extent than vertical thickness, floating at a slight elevation above the earth, usually less than one thousand meters. It has a grayish or ashy color. When its texture is visible, as is the case where one is nearly on a level with its base, it is seen to have a misty, ill-defined ragged base; but when seen from above, as from a mountain or balloon, it presents a glistening white, flat surface like the surface of a lake or sea, frequently with rounded protuberances like waves or billows on its surface.

Cumulo-stratus is a cloud form concerning which there has arisen as many differences as in the case of stratus. Howard defined cumulo-stratus thus: "*Nubes densa, basim planam undique supercrescens, vel cujus moles longinqua videtur partim plana partim cumulata.* — The cirro-stratus blended with the cumulus, and either appearing intermixed with the heaps of the latter or superadding a wide-spread structure to its base." His picture shows a cumulus-like cloud with an outspreading overhanging top. In his detailed description of cumulo-stratus he says: "When the cumulus increases rapidly, a cirro-stratus is frequently seen to form around its summit, reposing thereon as on a mountain, while the former cloud continues discernible in some degree through it. This state continues but a short time. The cirro-stratus speedily becomes denser and spreads, while

the superior part of the cumulus extends itself and passes into it, the base continuing as before, and the convex protuberances changing their position till they present themselves laterally and downward. More rarely the cumulus alone performs this evolution, and its superior part constitutes the incumbent cirro-stratus. In either case a large, lofty, dense cloud is formed which may be compared to a mushroom with a very thick, short stem." These descriptions show that what Howard considered typical cumulo-stratus was an incipient shower cloud or a shower cloud viewed from a distance. In Kaemtz's "Meteorology" (p. 117), by C. Walker, London, 1845, it is said: "When the cumulus clouds are heaped together, and become more dense, this species of cloud passes into the condition of cumulo-stratus which often assume, at the horizon, a black or a bluish tint, and pass into the state of nimbus or rain cloud." He introduced the name *strato-cumulus* to describe those dark balls, or rolls of cloud which are still by many recorded under the name of "cumulo-stratus." Karl Fritsch, in his memoir, "*Ueber die Periodische Erscheinungen am Wolkenhimmel*," Prag, 1846, besides the strato-cumulus, recognized two forms of cumulo-stratus, namely, flat cumulus and cumulus with outspreading overhanging base.

In "Classification des Nuages," Upsala, 1880, p. 7, Hildebrandsson says in describing the cloud called cumulo-stratus at Upsala: "Lorsque les cumulus ont une densité plus grande et une coloration noirâtre, lorsque leurs masses isolées sont plus rapprochée et forment comme une chaîne de montagnes, nous les appelons Cumulo-Stratus; les masses mamelonnées s'entassent les unes sur les autres, forment de vastes massifs de nuages d'un aspect menaçant qui s' accumulent à l' horizon; ils y présentent l' apparence d' une châine formée de pics neigeux dont les flancs sont colorés de ces teintes bleues spéciales aux horizons lointains, dont les sommets et les arêtes réfléchissent une lumière argentée." It is seen that the cloud called cumulo-stratus at Upsala was merely a massive cumulus.

In "Modern Meteorology," London, 1879, p. 130, Ley says in describing a certain form of flat-topped cumulus: "One might almost suppose, from parts of his description, that these clouds are what Luke Howard intended to designate as cumulo-stratus; but other remarks which both he, Foster, and others make about the cumulo-stratus, show that they intended by

this term to designate the cirrus-crowned cumulus, which I have spoken of to-night, simply as the shower cloud."

In the memoir on Clouds, in the *Annales du Bureau Central Météorologique de France, Année* 1880, Paris, 1881, Weilbach gave the name of *cumulus compositus* to the massive cumulus described above by Hildebrandsson, and the name of *cumulo-nimbus* to the shower cloud. In the "International Nomenclature," all cumuli, large and small, are described under the name of cumulus, and the name of cumulo-stratus has been dropped. All shower clouds whether seen at a distance or overhead are called cumulo-nimbus. The species of cumulo-stratus embraced in the following part of the definition used by the observers of the U. S. Weather Bureau is called strato-cumulus: — "The cumulo-stratus cloud is a form intermediate between the cumulus and the stratus. They are usually of a darker color than the cumulus. They will often be observed, when not too crowded, with the upper portion composed of forms like the cumulus and the lower portion of dark horizontal lines similar in shape to the cirro-stratus and stratus." (General Instruction to Observers of the Signal Service, p. 57.)

The definition of Nimbus given by Howard was: "*Nubes vel nubium congeries pluviam effundens.* — The rain cloud. A cloud or system of clouds from which rain is falling. It is a horizontal sheet, above which the cirrus spreads, while the cumulus enters it laterally and from beneath."

Those who began to put Howard's nomenclature into practical use were not long in discovering that rain falls from many different forms of clouds.

In the memoir of Fritsch, in 1846, quoted above, it is stated that rain may fall from any form of cloud; but he distinguishes two forms from which it most frequently falls, and calls one "nimbus" and the other "eigentlicher nimbus" (nimbus proper). The first is the complex cloud bank, "cirro-cumulo-stratus," from which rain falls in general storms, and the other is the shower cloud (or thunder-cloud), which develops almost exclusively from the "cumulo-stratus" and is usually only seen when the sky is partly cloudy. Ley calls attention to the two types of rain cloud in "Modern Meteorology," 1879; and in the "Suggestions for an International Nomenclature of Clouds," in the Quarterly Journal of the Royal Meteorological Society,

April, 1887, p. 160, Abercromby writes: "Theoretically every cloud from which rain falls should be called *nimbus;* but in practice all over the world rain falls from two distinct types of cloud — from a stratiform cloud, something like that which has just been called *strato-cumulus*, and from a mountainous *cumulus*."

The first of these is in the "International Nomenclature" called *nimbus* (by Weilbach called *nimbo-stratus*, and by Kassner *strato-nimbus*); and the second is called by Weilbach's name of *cumulo-nimbus*. (Weilbach also distinguishes between the smooth mantle-like rain cloud in the front of a cyclone and the ragged rain cloud of the centre and rear. The one he calls *nimbo-pallium* and the other *nimbo-stratus*.)

By thus following the changes in cloud nomenclature since Howard, it seems clear that there has been a gradual evolution during which differences and distinctions not recognized by Howard have been established, and errors due to perspective, as in the case of the cumulo-stratus, have been corrected. Thus a distinction between high and low cirro-stratus and high and low cirro-cumulus has been established and the lower forms called alto-stratus and alto-cumulus. The stratus has been separated into fog and low sheet clouds, and two distinct forms of rain cloud recognized. These distinctions have been a gradual growth and are not merely the work of two men, for Abercromby distinctly says: "At Prof. Hildebrandsson's suggestion we examined the nomenclature used by different offices, and arranged the names systematically as given fully in Prof. Hildebrandsson's paper, 'Remarks concerning the nomenclature of clouds for ordinary use' (page 148), and we found that the differences did not seem irreconcilable. Eventually, we agreed that ten terms, all compounded of Howard's four fundamental types, — *cirrus, stratus, cumulus, nimbus*, — would fully meet the requirements of practical meteorology, with the least disturbance of existing systems." (Quarterly Journal of the Royal Meteorological Society, April, 1887, page 155.) Hildebrandsson further says that the ten cloud forms described were already recognized in the nomenclature used in Portugal. Hence the International Cloud Nomenclature, adopted at Munich, represents the highest progress in cloud nomenclature which the world is yet ready to accept for general use; and no official bureau should hesitate to accept it for fear that the system is

merely temporary and will soon be changed. Progressive development will undoubtedly continue, but change will in all probability be slow. As an example of a change which seems most likely to be the next step of progress, it may be said a want is already beginning to be felt for a distinction between alto-stratus and the cloud which immediately precedes the low ragged nimbus in cyclones, for which the name *pallio-stratus* has here been suggested. This is the cloud sheet from which rain usually begins to fall in the front part of cyclones. All dark cloud sheets between the cirro-stratus level and the cumulus level, a difference in altitude of 7,000 meters, are now called alto-stratus, and it does not appear probable that meteorologists will long continue to class under the same name cloud sheets at such great differences in altitude and with a recognizable difference in appearance.

It seems improbable that any essentially new system of nomenclature will supplant this one based on natural growth and widespread usage, and its general adoption is perhaps not far distant; but it is hoped the International Committee will not add confusion by adopting any definition or picture of stratus in which the idea of "horizontal sheet" is not embodied.

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## THE NEWSPAPER WEATHER MAPS OF THE UNITED STATES.

R. DE C. WARD.

THE growing interest of the American public in meteorology during the past few years, especially as regards the weather maps and forecasts, has led to the publication of daily weather maps in a large number of our daily newspapers. The great importance of this means in educating the public in the meaning and use of the maps has induced the writer to collect some of the facts in this connection in order to give the readers of the JOURNAL information on this subject, and, if possible, to secure a more general publication of these maps.

The subject of newspaper weather maps is thus spoken of in Brig.-Gen. Albert J. Myer's Annual Report as Chief Signal Officer for the year 1879, pages 210, 211: "For a number of years past the attention of the office has been given to the sub-

ject of the preparation of a weather chart of such character as to appear printed in the newspaper journals throughout the United States. Charts of this character have been much sought for. . . . The popular demand has been pressing. The office has fully appreciated the propriety of the demand and the value of the results to be had from the study of such charts could they be made to appear simultaneously in the different cities. The work has been surrounded with unusual difficulties. The preparation of newspaper weather charts is not difficult, and such charts have long since appeared in some of the prominent European cities. The journals in which these charts have appeared have been located, however, in the city in which was the office at which the meteorological charts had been prepared. It was not of record that a weather chart prepared at any central office in Europe or the United States, had been so arranged for that it could be telegraphed in such form as to appear in the lines of its charting simultaneously in the journals of different cities, each city widely separated from the others, and this telegraphing and printing so rapidly done that the map might accompany the printing at any city of the data for the day, from the study of which data the map itself had been charted at the central office in some other city. The duties of this office are of such a nature that all of the chart-telegraphing must be upon plans that will enable all of the conditions thus stated to be fulfilled."

An interesting result of this plan of telegraphing the daily weather map was accomplished in connection with the Centennial Exposition at Philadelphia in 1876, as stated in the Report of the Chief Signal Officer for 1876 (page 116), and in later Reports. Weather maps charted at the Washington office of the Signal Service were transmitted each day in the lines of the charting by telegraph to the Exposition at Philadelphia, and formed the basis of the daily weather maps there issued from the Signal Service station in the Exposition grounds. The New York *Herald*, printed on the grounds of the Exposition on May 12, 1876, published a weather map based upon the data telegraphed from Washington on that day, and this is believed to have been the first newspaper weather map ever printed in the United States.

"These charts," Gen. Myer goes on to say, "were transmitted by process of autographic telegraphy which could not be effec-

tive at great distances. They required special instruments. Within the year past the studies and experiments conducted at this office and having relation to this subject have resulted in such plans that it is now found not difficult to transmit to any city which can be reached by telegraph, and without the use of special telegraphic instruments, such data as will permit the charts prepared in the office to be exhibited in any city or cities to which the data are sent, in chartings precisely similar, of any size, and to appear printed in the columns of the daily journals at the same time that the forecasts, had at this office from the study of the original chart, appear printed in the same journal."

The first regular daily newspaper weather map printed during an extended period was published in the New York *Graphic* from May 9, 1879, to Sept. 14, 1882. This map was published through the direct co-operation of the Signal Service and the *Graphic*, and appeared daily except Sunday. In Gen. Hazen's Annual Report as Chief Signal Officer for the year 1881 (page 26), the statement regarding the *Graphic* map is as follows: "While no impediment now exists in the telegraphic transmission of the weather chart, there still remains a practical difficulty to overcome in the prompt preparation of the plate from which the chart is printed." Gen. Hazen's report for the year 1882 (page 64) contains the following: "The daily weather chart — in the *Daily Graphic* — has been continued. During the greater part of the year this chart was a facsimile of the morning weather chart traced in this office (Washington), which was telegraphed in special cipher to the observer in charge of the New York station, who prepared the chart for publication. Recently the chart has been prepared by the observer in New York from reports received by him, thus saving the expense of telegraphing the chart from this office, and at the same time securing one which gives perfect satisfaction. Experiments have been made during the year with a view of securing the publication of similar weather charts in other journals, printed from stereotyped plates, and the results promise the solution of this difficult undertaking in the near future."

The last reference to the *Graphic* maps in the annual reports is in that for 1883, in which is found the following item under a list of amounts saved during the year: "Discontinuing map published in the *Daily Graphic*, Oct. 1, 1882, to June 30, 1883, $2,370.00."

It should be noted that the difficulty which used to exist with regard to telegraphing the maps in the lines of their charting, or in special cipher, has now been largely done away with. The stations at which local weather maps are issued, about seventy-five in number, have telegraphed to them each day from Washington sufficient data to enable the observers at those stations to draw a daily weather map. When a large weather map has been made for the Weather Bureau it is, of course, a simple matter to draw a small map for publication in the papers, and this is the system adopted in the cases where newspaper maps are now printed.

At the present time four daily papers in the United States print weather maps regularly, viz. : the Boston *Herald*, the New Orleans *Times-Democrat*, the Cincinnati *Tribune*, and the San Francisco *Examiner*. Of these papers the Boston *Herald* was the first to begin this publication, and has therefore printed the maps longer than the other three papers of which these maps are now a regular feature.

The Boston *Herald* began the publication of the daily weather map on Sept. 13, 1892, the arrangement in regard to the matter being that the *Herald* shall pay for the plates, and the observers of the Weather Bureau in Boston shall prepare the map. This agreement was made by Mr. S. A. Wetmore, city editor of the *Herald*, and Mr. J. W. Smith, Local Forecast Official at Boston. The chalk plate is prepared by one of the observers on the basis of the 8 A. M. observations every day excepting Sunday, and is usually delivered at the office of the *Herald* before 11.30 A. M. Messrs. A. W. Crosby, T. L. Bridges, and F. A. Tower take turns in making the map. A type-metal plate is then cast, and the map is ready for publication in the first of the afternoon editions of the paper. It is printed in all the afternoon editions, generally on the last page, together with the forecast, synopsis, explanation of the map, etc. The *Herald's* weather map has been printed continuously since Sept. 13, 1892, with one exception. The failure to print on this one occasion was at once noted by many of the readers of the paper, several of whom wrote letters to the editor, stating their interest in the map, testifying to its educational value, and requesting its continued regular publication.

The Boston *Herald* weather map herewith printed is that for

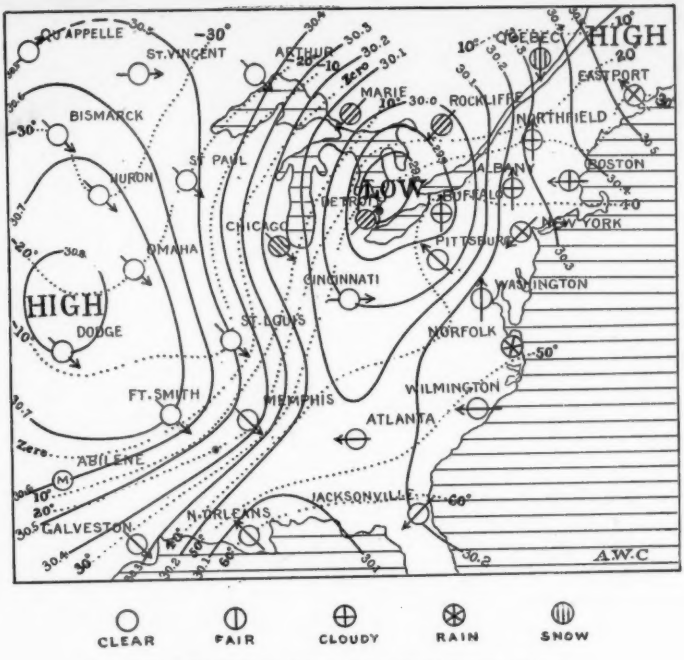
January 24, 1894, 8 A. M. It was prepared by Mr. A. W. Crosby, of the Boston office of the Weather Bureau.

The New Orleans *Times-Democrat* began the publication of the daily weather maps on Jan. 19, 1893, at the special request of Mr. Robert E. Kerkham, Local Forecast Official at New Orleans, and Director of the Louisiana State Weather Service. The map is prepared at the Weather Bureau in New Orleans from the 8 P. M. observations each day, and is printed on the morning of the day following. It is drawn on a chalk plate by Mr. Kerkham, or by one of his assistants, under his direction. In connection with the map there are published each day a synopsis of the weather conditions portrayed on the map; an explanation of the map; the forecast; local data as to precipitation, temperature, etc.* The agreement regarding the map is that the *Times-Democrat* furnishes the plates and the map is drawn by the observers at the Weather Bureau. The plates are made by the Weather Map Engraving Company, of St. Louis, Mo., and have the outline of the United States and the several stations of the Weather Bureau stencilled on them.

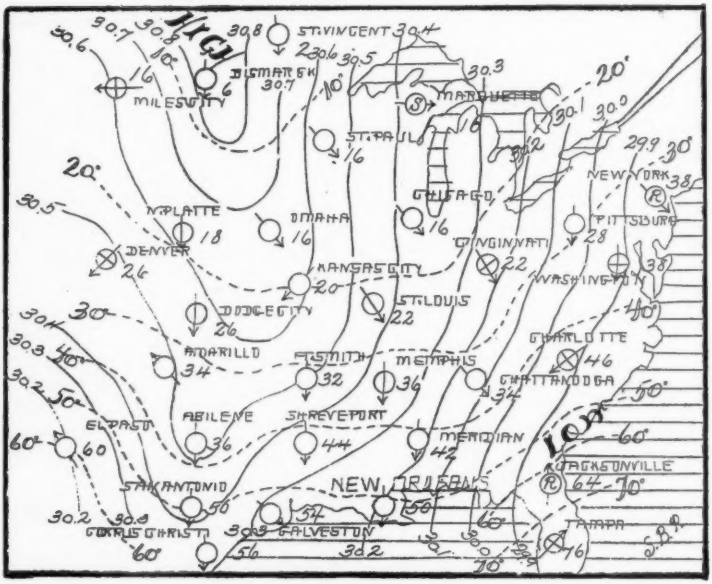
The *Times-Democrat* weather map herewith printed is that for 8 P. M., March 25, 1894, and was made by Mr. S. B. Pfanner, under the direction of Mr. Kerkham.

The Cincinnati *Tribune* began the publication of a daily weather map on Oct. 5, 1893. The map is made at the Weather Bureau in Cincinnati from the 8 P. M. observations each day, the assistants at that station, Messrs. Al. Brand, M. E. Blystone, E. B. Richards, and C. D. C. Thompson, taking turns in preparing the chalk plate. Mr. S. S. Bassler, Local Forecast Official at Cincinnati, has the general oversight of the work. Mr. Bassler believes that the value of these maps is very great, both from a business and from an educational point of view. In addition to the map the *Tribune* prints daily an explanation of the chart; a synopsis of the weather; local data as to precipitation and temperature, etc.; a comparison with similar data on corresponding dates of the past three years, and the forecast.

* In the *Louisiana Weather Journal and Agriculturist* for April 10, 1894, Mr. Kerkham had an article on "Weather and River Forecasts," in which he gave some account of the *Times-Democrat* map, and published a sample map. Regarding the value of the newspaper maps, Mr. Kerkham writes as follows: "I know they are very highly appreciated by the commercial and agricultural interests of this section of the country."



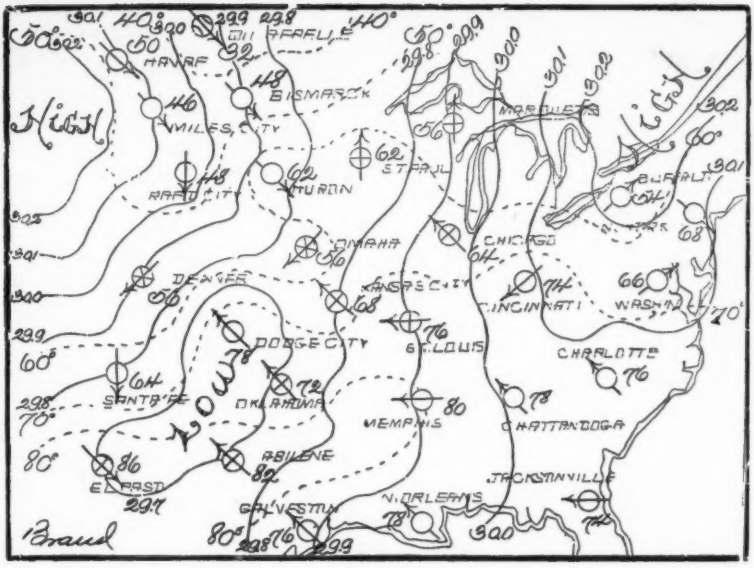

THE BOSTON "HERALD" WEATHER MAP.




Explanatory Symbols.

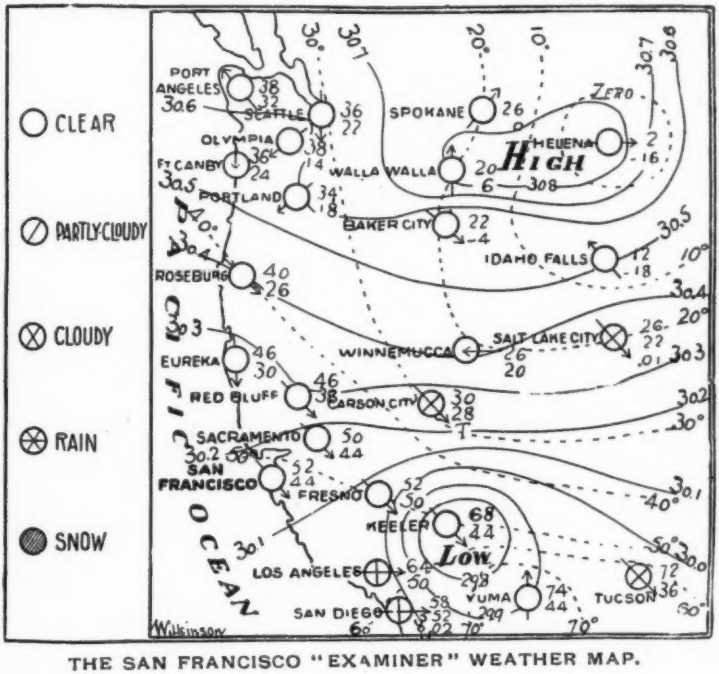
○ Clear, ◑ Partly Cloudy · ⊕ Cloudy; Ⓡ Rain; Ⓢ Snow.

THE NEW ORLEANS "TIMES-DEMOCRAT" WEATHER MAP.




○ CLEAR ◐ PARTLY CLOUDY ⊕ CLOUDY ⊗ RAIN ▨ SNOW

THE CINCINNATI "TRIBUNE" WEATHER MAP.




THE SAN FRANCISCO "EXAMINER" WEATHER MAP.

As a sample of the *Tribune's* weather maps we print herewith the map for 8 P. M., May 9, 1894, prepared by Mr. Brand.

The first weather map published in a newspaper on the Pacific Coast appeared in the San Francisco *Examiner* on Jan. 20, 1894. The local forecast office of the Signal Service was established in San Francisco in February, 1885, under the charge of Capt. Robert Craig, of the Signal Corps, this being the first forecast office established outside of Washington City. Ever since the opening of the San Francisco office efforts have been made by the various forecast officials in charge to have the newspapers of that city print a daily weather map. These efforts were unsuccessful until January of the present year, when Mr. B. S. Pague, Local Forecast Official in charge of the San Francisco station, submitted the plan of publishing a daily weather map to Mr. W. R. Hearst, proprietor of the San Francisco *Examiner*, who agreed to print the map. The *Examiner* maps are prepared by what is known as the zinc plate process. A copy of the official evening map is drawn at the Weather Bureau in India ink, on a small outline map furnished by the *Examiner*. This copy is made and delivered at the *Examiner* office before 8 P. M., 120th Meridian time (11 P. M. Eastern Standard Time). It is there reduced in size one-third by photography, and a zinc plate is then made, from which the map is printed. With the map the *Examiner* publishes an explanation of the map; rules as to "How to make your own Forecast"; a table of maximum and minimum temperatures at the principal Eastern stations; a synopsis of the weather conditions over the country, and the official forecast.

The *Examiner* weather map herewith printed is that for Feb. 21, 1894, and is based on the 5 P. M. (Pacific time) observations of that day. It was published in the *Examiner* of Feb. 22, 1894. The map shows decided fair cool weather conditions, typical of Pacific Coast weather changes peculiar to the winter months. The low pressure area shown at Keeler first appeared central at Vancouver Island on the morning of Feb. 17. An area of high pressure to the north of Montana forced the cyclonic area southward over the western portion of Washington and Oregon, and thence southwesterly along the crest of the Sierra Nevada Mountains. Cyclonic areas of this nature give the typical winter rain conditions, and this one, like the others

of its kind, gave rain, and was followed by an indraught of cold air from the anticyclone in Montana, which brought fair weather and frost over the Pacific Coast States.

The following papers have at one time or another within the past few years published daily weather maps: Cincinnati (O.) *Commercial Gazette;* Atlanta (Ga.) *Constitution;* Louisville (Ky.) *Courier Journal;* Kearney (Neb.) *Daily Hub;* New Haven (Conn.) *Register;* St. Louis (Mo.) *Republic, Chronicle, Post-Dispatch* and *Star Sayings;* Cleveland (O.) *Plain Dealer;* Galveston (Tex.) *Daily News* and *Evening Tribune;* Memphis (Tenn.) *Commercial;* New York *Herald* and *World;* Pittsburg (Pa.) *Dispatch;* Buffalo (N. Y.) *Evening News;* Cincinnati (O.) *Times-Star;* Detroit (Mich.) *Free Press;* Minneapolis (Minn.) *Journal* and *Tribune,* and Springfield (Ill.) *Monitor.* For various reasons the publication of the maps in these papers was discontinued. The Cincinnati *Commercial* (now the *Commercial Gazette*) published a daily (including Sundays and holidays), weather map from April 12, 1881, until November, 1892, this being the longest continuous period during which any newspaper in the United States has ever published a daily map. The maps were made on a type metal base by Mr. S. S. Bassler, formerly of the United States Signal Service (1872–1877) and later (since November, 1892) Local Forecast Official of the United States Weather Bureau at Cincinnati. On Mr. Bassler's appointment to his present position the *Commercial Gazette's* weather map was discontinued.*

The Atlanta *Constitution* began to print weather maps made on chalk plates, on Nov. 19, 1891, Mr. Park Morrill, Local Forecast Official at Atlanta, and Director of the Georgia State Weather Service, having prepared the plate, base map and all. Since that time the printing of daily weather maps has been adopted by many papers, and the demand thus created has resulted in the manufacture of chalk plates with the base map

* Mr. Bassler also issued, for a short time in 1886, a small weekly paper called *The Weather Journal,* the principal feature of which was a set of twenty-one charts, giving the isobars, isotherms, and general distribution of precipitation three times a day for each day of the week of its publication. The publication of this paper was suspended owing to lack of support. Mr. Bassler also issued, in 1886, a little pamphlet entitled "The Weather Chart, with explanation of Weather Prediction," in which were printed fourteen small weather maps, illustrating weather changes, and the basis on which forecasts are made.

already drawn. The *Constitution* discontinued the maps over a year ago, but still publishes occasional maps, when some severe storm is in progress. The reason for the discontinuance was the feeling on the part of the editor that too few readers had sufficient knowledge of meteorology to enable them to make an intelligent use of the maps. The printed synopsis was considered of greater value to the general public.

Daily weather maps were printed in the Louisville *Courier-Journal* for about six months, commencing with January, 1893, but were discontinued on account of lack of space and because the results secured in the chalk plate process were unsatisfactory. The maps were very popular with the public, and there is a movement now on foot to induce the proprietors of the *Courier-Journal* to take the matter up again. The maps printed were prepared from the 8 P. M. observations. The *Courier-Journal* at present publishes weather maps about twice a month on the average, when unusual weather conditions occur.

The Kearney *Daily Hub* began printing the newspaper maps on April 20, 1893, and continued them until Oct. 1, 1893, when they were stopped on account of the expense involved. The chalk plates were prepared by Mr. H. H. Curley, of the Weather Bureau at Kearney, and cost the paper four dollars a dozen. The actual expense of each chart published was about thirty-three and one-third cents. The plate was 3 x 4 inches in size. The coast lines and stations were first traced, and then the map was drawn with hand-engraving tools. When the map was completed at the Weather Bureau it was taken to the newspaper office and stereotyped by one of the printers. The 8 A. M. observations were used as the basis for the map. The general public took a great interest in the matter.

The New York *Herald* has already been mentioned as the first newspaper in the United States to print a weather map. This publication was at the time of the Philadelphia Exposition in 1876. The *Herald* occasionally prints maps now, to illustrate special weather conditions of interest. The New York *World*, Detroit *Free Press*, Minneapolis *Journal*, Memphis *Commercial*, and Cincinnati *Times-Star* published daily maps for a short time only. They were discontinued because they were not considered worth the space, which it was thought could be filled with more interesting matter, or because of the expense. The

St. Louis *Republic* published the maps for a year or more, but it was found that they did not serve the purpose of popular information. A few of the readers of the *Republic* found the maps of great value, but the great mass preferred the ordinary printed record of the weather. The Pittsburg *Dispatch*, also, discontinued the maps partly because the usual printed synopsis was more generally appreciated, and partly because the maps occupied valuable space and did not make a good appearance, owing to the haste necessary in drawing them. The Cleveland *Plain Dealer* discontinued the map because it occupied too much space, and because it was found difficult to prepare the map in time for the press. The Minneapolis *Tribune* published the maps for three months and discontinued them because it was thought that they were not appreciated, and because of the expense and trouble incident to their preparation. One of the difficulties was the necessity of preparing the map in a very short time. In the case of the Buffalo *Evening News* it was found impossible to get out the maps early enough in the day to reach the persons who especially wanted them, viz., the farmers. During the time that the maps were printed in the *Evening News*, the first edition of the paper went to press at 10.30 A. M., which allowed very little time for the preparation of the map from the 8 A. M. observations. When printed in the later editions the maps occupied space that was needed for fresh news. The New Haven *Register* stopped the publication of the maps because interest in them was very limited, and because they took up considerable room, crowding out other matter. The editor of the *Register* intends to begin republishing the daily maps as a matter of historical interest, as soon as a new style of paper and a new press are adopted. The Galveston *Daily News* printed the 8 P. M. daily map during part of the months of March and April, 1892. It was discontinued because the telegraphic reports of observations were not received promptly, and consequently the map was often delivered to the paper at such a late hour at night that it was of considerable inconvenience to print it. The Galveston *Evening Tribune* printed the 8 A. M. map in April and May, 1892, but discontinued the publication because the paper gave up the engraving work it was then carrying on.

It may not be amiss to review the causes that have oper-

ated to bring about a discontinuance of the publication of the daily weather maps in those newspapers that have at one time or another printed them. It has just been seen that the chief reasons given for the discontinuance are the following: the maps occupy space that could be better filled with other matter; they are not sufficiently appreciated or understood by the mass of readers; the expense connected with their publication is considerable, and it is often impossible to have the plates ready in time to go to press. These causes have been beyond the control of the Weather Bureau, and such conditions must continue to prevail as long as the publication of the maps is a purely voluntary one on the part of the paper, as is the case now, or until it has been shown that such a publication possesses a direct pecuniary value to the paper. At present, as has been seen, there is nothing but a voluntary agreement between the newspapers that publish the daily maps and the Local Forecast Officials of the Weather Bureau who prepare the plates, by which the paper furnishes the plates and the observers draw the map. This agreement can be terminated at any time that the management of the paper so determines, and therefore the whole matter is on a very uncertain basis.

Various suggestions have been made looking toward a more permanent and a more general publication of the maps in our great dailies. It has been frequently urged that the Weather Bureau shall furnish the plates free of cost to those papers that will print the maps, but this plan is not feasible. For several reasons it is impossible for the Weather Bureau to be responsible for these maps, or to furnish the plates free of expense to the newspapers. The difficulties in the way of the voluntary system now in operation in Boston, New Orleans, Cincinnati, and San Francisco must, therefore, he removed, if there is to be a more extended publication of the maps. That this can be done in the majority of cases there seems to be little doubt. If those persons in each city who are interested in this matter would unite in asking the managers or editors of their newspapers to print a daily weather map, it is probable that their wishes would, in most cases, be gratified. A movement of this kind, headed by several influential citizens, and aided by the observers of the Weather Bureau, would be almost certain to meet with success.

Regarding the expense of the plates and the difficulty of having them ready in time, there is but one thing to be said. As soon as it is apparent to the managers of the papers that there is a demand for the maps, there will be no complaint on the score of expense or of delay. The four papers that now print daily maps have no difficulty on the ground of delay in furnishing the plates.

There can be no question as to the advantages which may result from the publication of weather maps in our great daily newspapers. The increasing demand on the part of the public for a wider distribution of the daily weather maps of the Weather Bureau has resulted in the issue of considerably over 1,500,000 copies of the maps a year. It should be noted, however, that the daily maps printed in the Boston *Herald*, the New Orleans *Times-Democrat*, the Cincinnati *Tribune*, and San Francisco *Examiner* ought also to be considered in determining the extent to which the daily weather maps are now distributed in the United States. The total yearly circulation of the weather maps in these four newspapers brings the number of weather maps annually printed and issued in the United States up to nearly 50,000,000. Large as this number is it should be larger still. The advantages, educational and otherwise, to be derived from the publication of weather maps in our daily newspapers, are very great. Many persons who have no particular interest in meteorology are tempted to examine the map when it is brought prominently before them in their newspaper, day by day, and to study out the facts on which the forecasts are based. In this way a general knowledge of weather changes is imperceptibly gained, and the reader becomes an intelligent and reasonable critic of the forecaster. Instead of finding fault blindly, as he very likely did previously, when the official forecast is not verified, the man who has gained an interest in the weather maps learns to look for the day's chart in his paper in order to discover the cause of the failure. In this way a valuable educational work is accomplished, which inevitably tends to make our citizens more intelligent in regard to this matter, and to give them greater interest in the workings of the Weather Bureau.

There are many other uses to which the daily newspaper map can be put. Many persons prefer to look at the map in connec-

tion with the forecast to having the forecast alone, and like to practise forecasting themselves, or to extend or qualify the official prediction. Others wish to know what the general conditions of weather are over other sections of country, and find the map itself much more useful than the printed synopsis of weather conditions. These are but a few of the many uses to which the newspaper maps may be put.

There are still several problems connected with this matter of the general publication of newspaper weather maps which have not yet been satisfactorily solved, but there is little doubt that a determined effort on the part of persons interested would secure regular publication of the maps in many of our daily papers, the editors of which do not at present think such matter worth printing.

The writer is especially indebted to Messrs. J. W. Smith, of Boston, Robert E. Kerkham, of New Orleans, S. S. Bassler, of Cincinnati, and B. S. Pague, of San Francisco, Local Forecast Officials of the Weather Bureau, for their kind assistance in furnishing him with information relative to the newspaper maps published in their respective cities, and also to several other observers of the Weather Bureau, and to the editors of the papers to whom he has written, for their courteous co-operation. The plates for the maps used in this article were very kindly given to the JOURNAL by the editors of the Boston *Herald*, the New Orleans *Times-Democrat*, the Cincinnati *Tribune*, and the San Francisco *Examiner*.

HARVARD UNIVERSITY, June 1, 1894.

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## PSYCHROMETER STUDIES.

PROF. H. A. HAZEN.

THERE have just come to hand tables for the psychrometer originally prepared by C. Jelinek, and now reissued by Dr. Hann in November, 1893. In the introduction there are a few remarks at pages 10 and 11 upon the behavior of the psychrometer below freezing that should not be allowed to pass unnoticed. I translate rather freely.

"It is a well-known fact that near and below the freezing

point the readings of the psychrometer are uncertain. To control these Dr. Wild has employed a hair hygrometer. Dr. N. Ekholm, in more recent time, during the stay of the Swedish international polar exhibition at Spitzbergen, 1882, 1883, through an abundance of comparisons between the psychrometer [unventilated] and the absolute hygrometer (dewpoint and chemical methods), has shown the nature of the error of the psychrometer and partly also a method of diminishing the same. He shows that the main point of the error lies not in the method of observation but in the method of calculating or reducing the observations, as the theory of the psychrometer formerly held is improved.

"From the mechanical theory of heat and the information gained by these later investigations, it follows that vapor from ice has a less pressure (tension) than that from water at the same temperature (the water can remain fluid far below the freezing point when in vapor molecules). Fischer has shown [1886] that at —10° C. the vapors from water and ice have pressures $2.28^{mm}$ and $2.03^{mm}$ respectively while at —30° C. these are $.74^{mm}$ and $.32^{mm}$. When the wet bulb is covered with ice we have no longer to deal with the pressure (tension) of water vapor but of ice vapor. If we compute with the usual pressure table so we see that the psychrometer will give too great relative humidity. When the dry and wet bulbs read alike under 32° (0.° C.) so the relative humidity is not one hundred per cent but the quotient obtained by dividing the vapor pressure of ice by that of water, for example, at —20° C. .84 ÷ 1.20 or 70%. If the water vapor in the air is of the ordinary pressure (tension) which often happens with temperatures below freezing, so is it the case, so soon as its pressure exceeds that of the ice vapor, at a relative humidity near one hundred per cent that the water vapor condenses itself upon the ice of the psychrometer and the latent heat of the same raises the reading of the wet above the dry bulb. This is mostly the reason of the not seldom phenomenon of a negative psychrometer difference. Ekholm shows that when the wet bulb has an ice covering, a correction of —.45° C. should be made, and with this value we can obtain, at least on the average, a very nearly correct relative humidity in the common psychrometer table. We must apply a constant correction at all temperatures, for, though the departure of the pressure of ice

vapor from that of water vapor increases with the lower temperature at the same time, there is a greater effect in increasing the psychrometer difference at low temperatures."

WIEN, November, 1893.

These remarks are most extraordinary, considering that the whole science of the psychrometer has been radically changed since 1884. Mr. Ekholm, in the far North, in 1883, carrying out the old methods that had been in vogue for scores of years, cannot be blamed for such a result, but this cannot be said of a study of this question made in 1893, after ten years of experiment. It would be difficult to introduce more errors in a statement of this kind, viewed in the light of more recent studies. After struggling for scores of years, trying to obtain consistent results with the unventilated psychrometer, and only succeeding in becoming more and more involved in confusion, the scientific world learned, through experiments with a well-ventilated psychrometer, the following facts: —

1st. That nearly all the difficulty found in using the wet and dry bulb thermometers vanishes when they are well ventilated, and this is pre-eminently the case at temperatures below freezing, or with ice on the wet bulb.

2d. That it is possible, with proper care, to reduce water on the wet bulb to 23° F. (—5° C.) without its forming ice, and by carrying a wet bulb into a freezing temperature and then lashing it to another in higher temperature it is possible to thoroughly ventilate both, one with ice and the other with water. Under these conditions both water and ice give absolutely the same result. (See this JOURNAL for June, 1884, page 64.)

3d. An enormous number of comparisons between the psychrometer and Regnault's condensing hygrometer at temperatures from 20° to 32° F. (—6.7° to 0.° C.) has shown precisely the same law above and below freezing. (See this JOURNAL for January and February, 1885, pages 342–347, and 396–402.)

4th. That at about 20° F. (—6.7° C.) the ice covering upon the wet bulb contracts and causes the reading to be too high. The proofs of this fact are as near perfect as they can be. (See Prof. Papers of the Signal Service, No. XVIII., page 28, and Annual Report of the Chief Signal Officer for 1890, page 661.) The latter may not be accessible to all, and I take the liberty to

copy the statement bearing on this point. The experiments for comparing the psychrometer and condensing hygrometer were made at very low temperatures in Minnesota during the winter of 1889–90. The first readings were as follows: dew point, —24.2° F., dry bulb, —16.5° and wet, —16.1°.

"It was plain that the air was nearly saturated, and that the wet bulb reading was vitiated by the contraction of the ice on the wet bulb. The amount of this contraction could be measured quite accurately by dipping the ice-covered bulb and dry bulb in a bottle of mercury kept at the air temperature. In this case no evaporation could take place from the ice [and, of course, no effect from condensing vapor], and hence the contraction was determined by simply comparing the thermometers in the bath. It was hoped that the amount of this contraction once determined for any bulb would remain constant for that bulb, but it was found impossible to wet a bulb twice in succession and make the ice [coating] sufficiently uniform to give the same contraction. The amount of this contraction depended on the thickness of the ice, and with thick ice it exceeded 1.0° F. It was found necessary to measure the contraction for each observation and apply it as a correction to the wet bulb reading. It was quickly found that the temperature of the ice-covered bulb should steadily fall from beginning to end. If the temperature rose at all, the ice seemed to take a set and the pressure was released from the bulb. . . .

"An attempt was made to remove the difficulty from this contraction, as the operation of getting it at each observation was exceedingly laborious and quite too delicate for good results,—certainly entirely out of the question in ordinary meteorological observations. It was thought that by mixing water with alcohol and wetting the bulb with the mixture the alcohol could be evaporated off, leaving so thin a film of ice that its contraction would be inappreciable. On trying the mixture it was found that the compound was more or less stable, and, while it did not freeze, yet the alcohol did not evaporate away as expected. It was also found that the contraction was entirely eliminated and that a fairly satisfactory result could always be obtained. This method I regard satisfactory, and far preferable to the ice-covered bulb, which can never give an accurate result below 20° F. (—6.7° C.). The method requires great care in its use for accurate

results, and I accordingly sought other means for accomplishing the same purpose, *i. e.*, of preventing the contraction of the ice from affecting the reading.

"If a very thin film of some substance impervious to water could be first placed on the bulb and that covered with muslin and wetted, the thin coat would take up the contraction and no effect would be produced on the reading. A coating of thin rubber cloth was put on the bulb. The 'rubber dam' proved perfectly satisfactory, and there was little difficulty in getting comparable results by the three methods: *a*, plain ice in a mercury bath; *b*, water and alcohol; *c*, ice and 'rubber dam.'

"These experiments showed that the law for the psychrometer above freezing was carried down to the lowest temperatures experienced, when the contraction was allowed for."

It should be noted that the suggested condensation of water vapor upon the ice, thus liberating latent heat and causing the higher reading, is entirely untenable, even if we grant that there is such a thing as a water vapor in the air and ice vapor near the ice. If such condensation were to go on there would be a continual accession of ice to the ice bulb, whereas, in fact, there is a continual diminution of the ice coat. The most important conclusion to be derived from past experiences is that no satisfactory experiments can ever be made without a thorough ventilation of the psychrometer.

APRIL 25, 1894.

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## PAPERS FROM THE PHYSICAL GEOGRAPHY LABORATORY OF HARVARD UNIVERSITY.

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## NO. 13. — LIST OF CLOUD PHOTOGRAPHS AND LANTERN SLIDES.

R. DE C. WARD, ASSISTANT IN METEOROLOGY IN HARVARD UNIVERSITY.

THE rapidly extending field which the teaching of meteorology is every year occupying in this country, and the desirability of supplementing the ordinary text-book and class work with illustrations, whenever possible, has led to the preparation of the following list of cloud photographs and lantern slides. The object has been to select a set of typical cloud forms, classified according to the international system, with a view to pro-

viding teachers of meteorology with a standard collection of cloud illustrations. The general use of the stereopticon has led to the preparation of both photographs and lantern slides of the various views, so that teachers may secure the photographs, or the lantern slides, or both, as they prefer.

Arrangements have been made with Mr. E. E. Howell, 612 17th St., N. W., Washington, D. C., to supply anyone with the whole collection, or with any number of single photographs or slides that may be desired, at the price of twenty cents for each mounted photograph, and forty cents for each slide. The whole collection of cloud photographs, twenty-eight in number, may be bought for five dollars.

The views entered on the present list were selected from a much larger collection of cloud photographs by Riggenbach, Mannucci, Eccles, Burnham, Todd, and others, belonging to the Physical Geography Laboratory of Harvard University, and used for purposes of illustration in the courses in meteorology. They were chosen from among the others because they best represent the various typical forms of clouds according to the present accepted standard classification. This classification is known as the Hildebrandsson-Abercromby nomenclature, and was recommended by a majority of the International Meteorological Conference held at Munich in 1891. Fourteen of the best views are marked by asterisks.

In the list herewith printed, a brief statement is given with each view as to the kind of cloud it illustrates, the average height of the cloud, and other facts of importance. These statements are not intended to replace the text-book, or to give all the information that an intelligent student will wish, but simply to describe the main features of special interest. This brief text is taken chiefly from the "Measurement of Cloud Heights and Velocities," made at Blue Hill Observatory, Readville, Mass., by Messrs. H. H. Clayton and S. P. Fergusson (Annals of the Astronomical Observatory of Harvard College, Vol. XXX., Part III., 1892), and from the "Elementary Meteorology," by Prof. William M. Davis (Ginn, Boston, 1894). Those who wish more extended information on this subject will find the first named publication of great value, as also the *Wolkenatlas* of Hildebrandsson, Koeppen and Neumayer (Hamburg, 1890). Mr. H. H. Clayton, of Blue Hill Observatory, has very kindly

assisted in the selection of the cloud views included in the present list and in the preparation of the text.

The average heights, roughly given in miles, are sufficiently accurate for general use. The exact mean heights, as determined by the measurements made at Blue Hill by Messrs. Clayton and Fergusson, are given in meters (1,609 meters equal one mile).

The present list is to be considered a provisional one. It is intended to prepare a new list as soon as the addition of other views to the present collection of the Physical Geography Laboratory of Harvard University shall make the selection of better illustrations possible. It is hoped that any persons who have good cloud views will send them for examination, with permission to reproduce them if desired.

CIRRUS clouds are the highest forms of clouds. They are thin, fibrous, and feather-like, sometimes appearing in long parallel lines, and sometimes in feathery, curled, tangled or clotted arrangement. As a rule they drift eastward, but they occasionally advance to the west in connection with storms. Their average velocity is nearly ninety miles an hour, and their height five miles and a half.

Met. 1. *Ordinary Cirrus* (Riggenbach). A common form. Average height in summer, 9,724 meters; in winter, 8,115 meters.

*Met. 2. *Plumed Cirrus* (Riggenbach). A fine view of a very beautiful form of cirrus. The height is the same as that of the ordinary cirrus.

*Met. 3. *Flocculent Cirrus* (Riggenbach). This view shows long streamers of cirrus being drawn out from small clots of cirro-cumulus. Average height in summer, 8,390 meters; in winter, 6,441 meters.

CIRRO-STRATUS. A thin white veil of cloud, usually more or less fibrous. Cirro-stratus, if not too thick, produces halos around the sun and moon, and from this, as well as from the great altitude of its occurrence, it is known to be composed of ice crystals and not water drops. This cloud is usually seen in advance of cyclonic storms, and is often the first sign of an approaching storm. The average height is five miles.

*Met. 4. *Flocculent Cirro-Stratus* (Riggenbach). Shows the striated character. Average height in summer, 9,681 meters; in winter, 7,227 meters.

Met. 5. *Cirro-Stratus in detached fragments* (Riggenbach). A lower form than the preceding one. A uniform veil of this character would form a typical cirro-stratus cloud cover. Average height, 8,754 meters in summer; 7,846 meters in winter.

CIRRO-CUMULUS. Small, white, cottony balls of cloud, in flocks. Flocks of small, detached, fleecy clouds. The separate balls or clots are not fibrous, like cirro-stratus. When well-defined and closely-grouped, cirro-cumulus

clouds give what is generally known as a "mackerel sky." The average height is four miles and a half.

Met. 6. *Cirro-Cumulus* (Riggenbach). The upper part of the view shows some typical cirro-cumulus flock clouds. When seen towards the horizon the individual particles cease to be visible, and take on the appearance of sheets. Average height in summer, 7,606 meters; in winter, 6,992 meters.

Met. 7. *Cirro-Cumulus* (Riggenbach). Another example of cirro-cumulus, showing a detached bank of this cloud.

*Met. 8. *Cirro-Cumulus* (Riggenbach). A low form of this cloud. The height is 6,406 meters in summer.

ALTO-CUMULUS. Large, more or less rounded balls, flat discs, or rolls of fleecy clouds in flocks; white, except here and there a dark shading. Average height, two miles.

Met. 9. *Alto-Cumulus* (Mannucci). A small part of an alto-cumulus sky. Average height in summer, 3,195 meters; winter, 2,931 meters.

*Met. 10. *Alto-Cumulus* (Riggenbach). General view of an alto-cumulus sky, showing the rolls near the horizon, and the more or less rounded balls nearer the zenith. The characteristic dark shading is well shown on the right of the view.

ALTO-STRATUS. A gray or blue veil of cloud, through which the sun and moon are faintly visible. The average height is three miles.

Met. 11. *Broken Alto-Stratus* (Riggenbach). This view shows the general appearance due to an alto-stratus cloud cover. The height is 4,225 meters in summer; 2,930 in winter. In the foreground there are detached masses of stratus.

*Met. 12. *Broken Alto-Stratus* (Burnham). This view was taken at the Lick Observatory, Mt. Hamilton, Cal. In the valley is seen the top of a stratus cloud, having the appearance of a lake.

STRATO-CUMULUS. Large gray balls or rolls, in close contact, usually covering most of the sky. The height is about one mile.

*Met. 13. *Ordinary Strato-Cumulus* (Riggenbach). Shows the more or less parallel arrangement of the rolls, and the general grayish appearance of the sky. Average height in summer, 1,957 meters; in winter, 1,830 meters.

Met. 14. *Festooned Strato-Cumulus.* Showing a festooning of the clouds, which makes them appear convex downwards. Otherwise the general appearance of the sky is about the same as in the preceding view.

Met. 15. *Strato-Cumulus* (Burnham). This view shows the appearance known as the "sun drawing water," the rays of sunlight seeming to diverge from the break in the clouds through which they come. The height of the clouds in this view, and in the one preceding, is 1,957 meters in summer; 1,830 meters in winter.

CUMULUS. Piled clouds, with conical or hemispherical tops and flat bases. These clouds are formed in local ascending currents of warm, moist air. They are the characteristic clouds of fine, calm summer days over the land. They form in the morning hours; increase to a maximum about noon

or a little later, and melt away in the late afternoon. Cumulus clouds, when their convectional ascent is excessive, develop thunderstorms. The average height of their base is about one mile.

*Met. 16. *Typical summer Cumulus* (Riggenbach). Shows the characteristic flat base, which marks the height at which condensation begins in the ascending mass of air, and the boiling up at the top. Attentive observation of such growing cumulus clouds will reveal many interesting changes of form. The average height of the top of the cumulus in summer is 2,181 meters; of the bottom, 1,473 meters; of the bottom in winter, 1,381 meters.

Met. 17. *Cumulus rising above the horizon* (Mannucci). A large mass of cumulus extending over the sky, showing the clean cut upper edge. The base of the cloud is not visible.

*Met. 18 and 19. *Ordinary summer Cumulus*, developing into a thunderstorm. (Morrison, Peterboro, N. H.) These views were taken at Peterboro, N. H., in August, 1891. The first one shows the cloud at 3.15 P. M.; the second, the same cloud at 3.17 P. M. The views are interesting as showing the changes of form in the two minutes' interval between the exposures. They represent the incipient stages of thunderstorm, or cumulo-nimbus, clouds, and are very characteristic illustrations of the growing cumulus clouds of warm summer afternoons. The heights are intermediate between those of the cumulus and those of the cumulo-nimbus.

FRACTO-CUMULUS. Flat, broken, ragged clouds of the cumulus type, often assumed during the early stages of cloud growth, and in storms.

*Met. 20. *Fracto-Cumulus* (Mannucci). The cumulus form of these clouds can be seen, but somewhat ragged and broken.

CUMULO-NIMBUS. Massive clouds from which showers fall. Cumulo-nimbus is the name given to the large overgrown cumulus clouds that have reached the dimensions of thunderstorms, having when fully developed above the "thunderheads" an outflow of alto-stratus or cirro-stratus, with a fibrous margin sometimes called "false cirrus." The under surface of these extended overflows from cumulo-nimbus clouds is sometimes curiously festooned, where the filmy cloud layers settle slowly to lower levels. The average height of the bottom of these clouds is about one mile.

Met. 21. *Distant Cumulo-Nimbus* (Riggenbach). This is a view of the top of a distant thunderstorm cloud. It shows on the left side the characteristic anvil-shaped top of cumulo-nimbus clouds, where they spread out in the upper currents. The average height of the top is 8,242 meters, and of the bottom, 1,202 meters. The lower portion of such thunderstorm clouds consists of water drops, while the upper portion may be of snow, even in summer, as is proved by the snow falling from thunderstorms on lofty mountains, while rain falls in the valleys.

Met. 22. *Distant Cumulo-Nimbus* (Riggenbach). The level base is faintly visible; the anvil-shaped top and "thunderheads" are clearly seen. (The slide of this view is slightly imperfect.)

*Met. 23. *Top of Cumulo-Nimbus* (Riggenbach). Fine view of the anvil-shaped top, and of the convex upper surface of the cumulus. On the left

side of the view the development of the anvil-shaped top from the main body of the ascending cumulus is well shown.

NIMBUS. A dense, dark sheet of ragged cloud, from which rain or snow usually falls. This name is applied to the wide-spread cloud of general storms. A nimbus is usually preceded by alto-stratus. The average height is less than half a mile.

Met. 24. *Nimbus* (Riggenbach). This view shows the dark, threatening sky commonly associated with general rains. The average height of the nimbus is 712 meters.

*Met. 25. *Nimbus* (Riggenbach). A typical nimbus cloud from which rain is falling.

STRATUS. A stratus cloud is a thin, uniform layer of cloud at a very low level; or detached, flat, structureless clouds. The name was originally applied to low-lying fogs, such as form on lowlands or in valleys at night, or in quiet winter weather. It has been extended to include low, foggy cloud sheets floating overhead, but with the base at a moderate height. The average height of stratus is about one third of a mile.

*Met. 26. *Stratus from beneath* (Riggenbach). Shows the drifting masses of stratus cloud and a sheet of stratus cloud covering the mountain summit.

Met. 27. *Stratus from above* (Burnham). Stratus seen from above, the view being taken from the Lick Observatory, Mt. Hamilton, Cal., at sunset. Fragments of the cloud are seen drifting among the trees in the foreground. The average height of the bottom of the stratus is 583 meters above the earth's surface in summer, and 503 meters in winter.

*Met. 28. *Stratus* (*or strato-cumulus*) *from above* (Jackson, Denver, Col.). This view was taken from Pike's Peak at sunrise. It represents what is commonly known as a "sea of clouds." (This may be composed of strato-cumulus clouds, as it is not possible to determine this point with certainty merely from the photograph.)

It is intended, as soon as practicable, to publish a list of selected views of fog, lightning, tornado effects, storm waves, damage by storms, ice-storms, hail, snow, etc., to be used as a supplement to this cloud list in teaching meteorology. This second list, like the one herewith published, will be made up from the collection of photographs and lantern slides in the Physical Geography Laboratory of Harvard University, and will be prepared on the same general scheme as the one here adopted.

PHYSICAL GEOGRAPHY LABORATORY, HARVARD UNIVERSITY,
CAMBRIDGE, MASS., June 1, 1894.

# CURRENT NOTES.

*Weather Bureau Notes.* — Mr. W. L. Moore was the successful competitor for the professorship. The result of the competitive examination was a tie between Messrs. Hammon and Moore. Both men were given further examination in forecasting. The difference is understood to have been very small. There was no other test but forecasting. It is of interest to know that there was only a difference of 5.4 per cent on the general average between the ten competitors.

On April 6 the 8 A. M. reports were all in at the Washington office at 9.09 A. M. This makes the total time required to gather all reports in a territory extending from Farther Point and Sydney in the Northeast to Jupiter and Key West in the Southeast; Corpus Christi and Los Angeles in the South and Southwest to Spence's Bridge and Edmonton in the Northwest, and not a single report missing, fifty-four minutes. This was the fastest time on record by four minutes. The map was on the lithographic presses at 10.42 A. M. (two colors are necessary on the morning map), and thirty-six minutes later was in the post-office. In other words, in three hours and eighteen minutes from the time the observer at any station began his observation, the lithographed synoptic map was in the mail.

Mr. Alexander McAdie has been relieved of his duties as Confidential Clerk, and by direction of the Secretary will undertake some experimental work upon Lightning.

A circular of information, "Protection from Lightning," has been issued by the Bureau.

Prof. Harrington has been elected a member of the Austrian Meteorological Society.

No representative of the Weather Bureau will be sent to the meeting of the International Committee of Meteorology and of the International Cloud Committee at Upsala in August.

*The Advent of Spring.* — In "Harper's Monthly" for May, Prof. Mark W. Harrington has an article entitled "The Advent of Spring." The isothermal line of 43.8° Fahr. may be taken as marking the advance of spring, and a chart is given showing the successive positions of this line on Feb. 1, March 1, April 1, and May 1. On Feb. 1, the isotherm of 43.8° crosses the United States from the vicinity of Cape Hatteras to the north of El Paso, whence it goes northwestward to the Pacific Coast, some distance north of San Francisco. Between Feb. 1 and March 1 the line moves but a short distance northward. On April 1 it passes over central New Jersey nearly westward to the vicinity of Denver; thence southward on account of the Rocky Mountain chain, and then northward again as far as Spokane Falls,

whence it goes westward to the Pacific. On May 1 all of the United States, except a small area in the northeastern part, is covered by spring.

An interesting feature of the month of May, brought out by Prof. Harrington, is the advance of a series of warm and cold waves across the United States. A study of the charted maximum and minimum temperatures, derived from fifteen years' observations, shows that three warm and two cold waves sweep over the country with marked regularity in May. The first warm wave enters on the Pacific Coast about May 2, crosses the country to the east and disappears over the Atlantic on the 12th. A cold wave follows this, appearing on the Pacific coast on May 4 and disappearing off the central Atlantic coast on the 16th. The second warm wave moves over the country between the 8th and 22d; followed, between the 14th and 24th, by the second cold wave, and this, in turn, by the third warm wave. This last wave begins in the extreme northwest on May 18, and disappears on the eastern coast in the vicinity of Cape Hatteras on May 30.

Spring, says Prof. Harrington, "comes from the southward and from the westward. It does not come by any means with absolute uniformity, but in fluctuations, here advancing and again retreating, and when we come to examine these fluctuations in detail we find they involve a series of warm and cold waves passing over the United States from west to east."

# BIBLIOGRAPHICAL NOTES.

## LUKE HOWARD ON THE MODIFICATIONS OF CLOUDS.

G. HELLMANN. *Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus: No.* 3. *Luke Howard. On the Modifications of Clouds, London*, 1803. Berlin. A. Asher & Co., 1894. 4to. Pages ix., 32. Pl. 3. Price, 3 marks.

Every student of the literature of meteorology must feel grateful to Dr. Hellmann for reproducing and putting within the reach of every one those epoch-making writings and charts concerning meteorology and terrestrial magnetism which are now out of print and rare. The reprint of Luke Howard's essay "On the Modifications of Clouds" is the third in the series, the two preceding being L. Reynmann's "Wetterbüchlein von wahrer Erkenntniss des Wetters, 1510," and Blaise Pascal's "Récit de la Grande Expérience de l' Équilibre des Liqueurs, Paris, 1648."

These reprints are on strong, thick paper, evidently intended to endure, and with neat white covers, which are, however, on account of their color, easily soiled.

In the introduction to the essay on Clouds, Hellmann gives a short sketch of Howard's life, and also a brief history of the reproduction of Howard's essay and accompanying cloud sketches.

The following notes are taken from the sketch of Howard's life: Howard was born in London on the twenty-eighth of November, 1772, and after the completion of his school years learned the trade of an apothecary. In 1796 he formed a business partnership with William Allen and built a chemical manufacturing laboratory at Plaistow, Essex, near London. About 1805 he moved to Strafford, and in 1812 changed his residence to Tottenham. Here, or on his estate at Ackworth, Yorkshire, he died on March 21, 1864, at the age of ninety-two. His study of clouds appears to have been taken up in the midst of a busy life, and perhaps as a scientific recreation. His first essay, "On the Modifications of Clouds," was read in the winter of 1802–03 before the *Askesian Society*, a small scientific society of which he was a member, and published in "Tilloch's Philosophical Magazine," Vols. XVI. and XVII., July—October, 1803. The first essay of Howard's was a reprint from this magazine for distribution by the author. A second edition of this was published by Harvey and Darton, London, 1832; and a third edition after Howard's death, edited by W. Dillworth Howard and Eliot Howard, was printed by John Churchill & Sons, London, 1865. The second edition was not accompanied by cloud pictures, since Howard said, "the copying of a particular *form* of each tends too much to limit the reader's views, in looking for it in the sky; while the exhibition of many varieties would only

serve to perplex him at the outset." The third edition was illustrated by cloud pictures collected by the editors. Howard's nomenclature was introduced into Germany by Goethe about 1820, and gradually came into use in all parts of the world.

Howard's nomenclature is too well known to need detailed description, but it may be said in brief that he recognized three primary cloud forms, Cirrus, Cumulus, and Stratus, and four intermediate modifications, Cirro-cumulus, Cirro-stratus, Cumulo-stratus, and Cumulo-cirro-stratus, or Nimbus. The difficulties and confusion which have arisen in the practical use of Howard's nomenclature will be discussed in another place.

A comparison of the cloud pictures given in Hellmann's reprint with those in a copy of Howard's original essay at Blue Hill Observatory shows that the pictures have been reproduced with wonderful fidelity and accuracy. In fact, except in the new appearance of the latter, it is difficult to detect any difference between the original and the reproduction. The book is in every way a reproduction of Howard's; even the appearance of the type and the paragraphing is the same as in the original.

H. H. C.

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## TOTAL ECLIPSES OF THE SUN.

MABEL LOOMIS TODD. *Total Eclipses of the Sun.* Columbian Knowledge Series. No. 1. 16mo. Boston. Roberts Brothers, 1894. Pp. xv, 244. Illustrated. Price, $1.00.

Mrs. Todd's "Total Eclipses of the Sun" is a very readable summary of the principal results regarding this interesting subject. It is written in a plain, straightforward way, and is well suited, as is stated in the preface, "to give very unprofessional information to those without technical knowledge." Many persons who are interested in this attractive branch of astronomy, but who hesitate to take up a more advanced work, will find Mrs. Todd's book admirably adapted to their purpose. It is abundantly illustrated.

There are several meteorological phenomena associated with solar eclipses which should receive careful attention in future eclipses. Among them may be mentioned the changes of pressure and temperature, already accurately noted in several instances, and especially the changes in wind direction and velocity, the deposition of dew, etc. "Eclipse winds" have been reported as blowing from the space covered by the moon's shadow, and careful observation by many observers would doubtless throw much light on this very interesting, though very rare and unimportant, class of winds.

On page 205 mention is made of the new application of meteorology to eclipse work, namely, the determination, before the occurrence of an eclipse, as to what stations will be likely to afford the best weather at the time of the eclipse; and reference is made to Prof. Todd's researches in this connection before the total eclipse of April 16, 1893, published in this JOURNAL, Vol. IX., 1893, pages 379–402 ("Data–chiefly meteorological–bearing upon the Selection of Stations for observing the Total Eclipse of 1893, April

16"). Prof. Todd's investigation was the first one in which this plan was systematically carried out with some approach to comprehensiveness.

Mrs. Todd's book is the first in the Columbian Knowledge Series, edited by Prof. D. P. Todd, and published by Roberts Bros. of Boston. This series is to include timely, readable, and authoritative monographs on subjects of wide and permanent interest and significance. The treatment is to be scientific where best suited to the purpose, but the language will be untechnical.

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## THE STORY OF A STORM.

F. W. SPRAGUE. *The Story of a Storm.* A History of the Great Tornado at Pomeroy, Calhoun County, Iowa, July 6, 1893. 8vo. Chicago, 1893. 228, 17 pp. 18 pl.

The "Story of a Storm" is a book which we have read with interest from beginning to end. It is a compilation of newspaper accounts and narratives given by survivors and eye-witnesses of this tornado, which was one of the most destructive on record. There is naturally a lack of system in the present volume, and many points are omitted which we should like to see in the text. Still, the various narratives contain a great number of noteworthy facts in connection with the curious freaks of the tornado, many of them of importance in relation to the theory of tornadoes. We note, under this heading, such statements as the following: "From a driven well near the school-house the pump and forty feet of tubing were torn out" (page 5). "Near the centre of the track in Pomeroy, a number of buildings evidently exploded outward, from the force of the expanding air within, the roofs being carried away, and the sides and the ends of the structures were left lying as they fell, toward the four points of the compass" (page 43). One of the most noteworthy statements in regard to the diminished atmospheric pressure is found on page 52, where it is stated that some persons "felt for a moment as though there were no air in the rooms or places where they had sought refuge, which was doubtless actually the case, and some of these, who were in caves or cellars, sought to open a door or window for purposes of ventilation, when the trouble was not that the rooms were closed up, but that the air had been sucked out."

Another interesting note is found on page 31, where the development of the tornado from the thunderstorm which preceded and accompanied it is described in the following words: "As it (the thunderstorm) advanced it was seen to be in violent commotion, a strong ascending current appearing in its midst." This is in line with the statement made by Prof. W. M. Davis, in his recent work on "Elementary Meteorology," page 275, "The best suggestion yet offered for the development of tornadoes in thunderstorms is based on the inferred occurrence of exceptionally strong updrafts here and there in the thunderclouds."

Mr. Sprague's book will serve a useful purpose in preserving, in permanent and attractive form, these reports of eye-witnesses. The volume is illustrated with several fair photo-engravings of the destruction caused by the tornado.

## TITLES OF RECENT PUBLICATIONS.

FURNISHED BY MR. OLIVER L. FASSIG, LIBRARIAN, U. S. WEATHER BUREAU, WASHINGTON, D. C.

An asterisk [*]indicates that the publication thus designated has been received by the Editor of this JOURNAL.

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